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Session 1D: Land Use

Kentucky Water Resources Research Institute, University of Kentucky

MOUNTAINTOP MINING AND SUSTAINABLE DEVELOPMENT OPPORTUNITIES FOR APPALACHIA

By J. Steven Gardner, P.E., P.S., President/CEO

Engineering Consulting Services, Inc.
340 South Broadway, 200
Lexington, Kentucky
859-233-2103
jsgardner@engrservices.com

The Appalachian Region of the United States has sometimes been termed, "…a third world country within the U.S.". Mountaintop Mining (MTM) in Appalachia has been blamed for flooding and water quality problems and challenged in recent years by continuous reinterpretations of environmental regulations for this long accepted coal mining practice. Effective planning, permitting and reclamation for Mountaintop sites can result in a "Higher and Better Land Use". MTM creates opportunities for development as a byproduct of the mining process and many consider it a value-added process. This analysis of MTM and Post Mining Land Uses attempts to set out a conceptual framework for establishing increased land and environmental values and presents a new way of representing mining to the public. MTM can epitomize the concept of Sustainable Development within the borders of the United States in a region that needs new development opportunities.

NOTES

SPATIAL CHARACTERIZATION OF KENTUCKY'S 2005-2001 LAND COVER CHANGE, A KENTUCKY LANDSCAPE CENSUS PRODUCT

Demetrio P. Zourarakis[1], Michael Palmer[2], and Sudha Maheshwari[3]

[1] Ph.D., Remote Sensing and GIS Analyst (Kentucky Div. of Geographic Information)
[2] Senior Geomatics Analyst (Sanborn, Inc.)
[3] Ph.D., Operations Manager (Sanborn, Inc.)

501 High Street 9th Floor
Frankfort, KY 40601
502-564-2480
demetrio.zourarakis@ky.gov

The Kentucky Landscape Census Project (KLC) is releasing the final version of the 2005, Kentucky update to the 2001 National Land Cover Dataset (NLCD01). This update product is derived from 2001 Landsat 7 ETM+ and 2005 Landsat 5 imagery, by calculating a change vector analysis mask based on the 2-date tasseled cap transformation (Lillesand et al., 2007). The presence or absence of change was captured with a success rate of 96%. While a deterministic result shows 58.8% classification accuracy, a representative fuzzy assessment of the classification shows a favorable overall classification accuracy of 79.9% (Congalton and Green, 1999; Congalton and Macleod, 1998; Ginevan, 1979). A total surface area of over 240,000 acres (approx. 98,000 Has) was mapped as experiencing change between Anderson Level II classes. The most frequent "source" class was forest with a loss of 153,000 acres (approx. 62,000 Has.), while scrub/shrub and grassland were the majority competing "target" classes, with gains of 91,000 acres (approx. 37,000 Has.) and 87,000 acres (approx. 35,000 Has.), respectively) (Fig. 1). Spatial distribution metrics were calculated referenced to the 12-digit hydrologic unit dataset (http://kygeonet.ky.gov) including: percentage of total change, percent of 12-digit hydrologic units (HUC12), and Euclidean distance. Distinct spatial clustering of binary change was observed for groupings of HUC12s, corroborating the trends in type and direction of land cover change (Figs. 2a, 2b, and 2c).

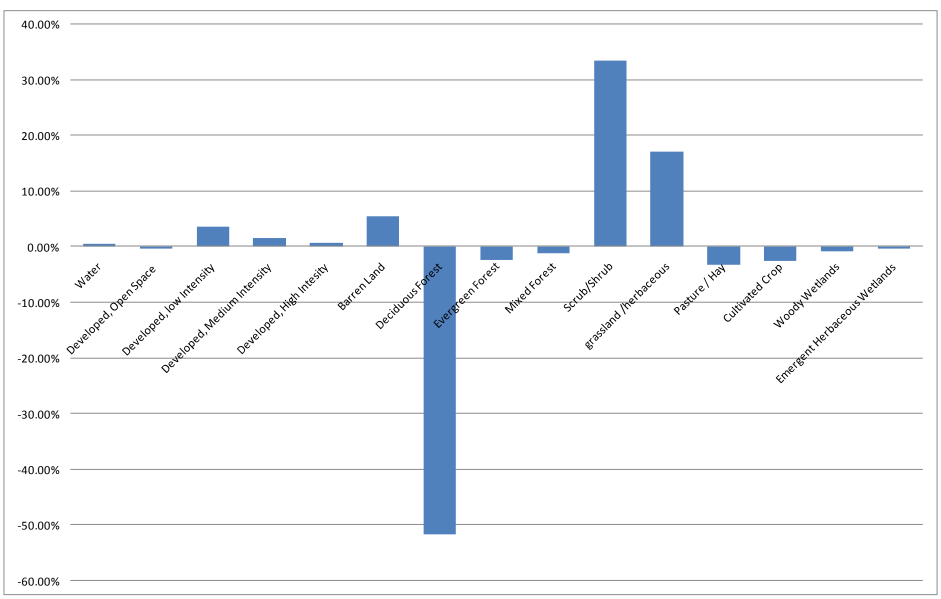
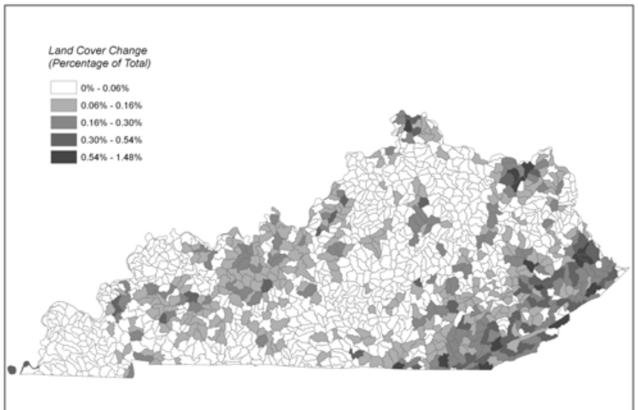
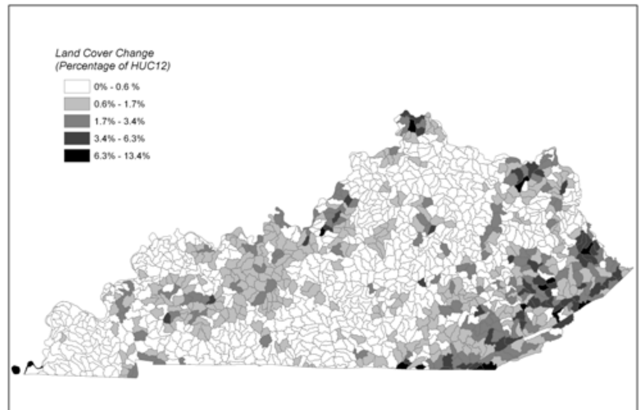


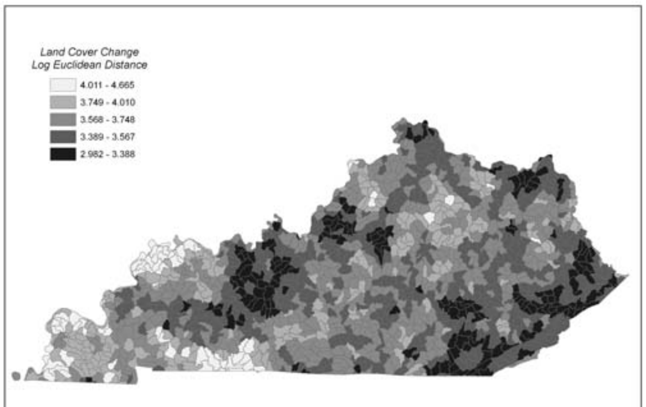
Figure 1. Magnitude and direction of land cover change area in Kentucky between 2001 and 2005.



(a)



(b)



(c)

Figure 2. Change relative to total land cover change area (a), HUC12 area (b); mean Euclidean distance (c).

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FEASIBILITY STUDY OF COVER-COLLAPSE RATE
IN THE WESTERN PENNYROYAL KARST OF KENTUCKY

James C. Currens, M.S., P.G.
Randall L. Paylor, M.S.
Kentucky Geological Survey
University of Kentucky
228 Mining and Mineral Resources Building
Lexington, KY 40506-0107
859-257-5500 ext. 160 and 161
currens@uky.edu; rpaylor@uky.edu

Cover collapse is the sudden and unpredictable collapse of the unconsolidated cover over karstic bedrock. Cover collapse damages buildings, roads, utility lines, and farm equipment. It has killed livestock, including some thoroughbred horses, and has injured people. Predicting the precise location and timing of collapse remains enigmatic. Measuring a rate or frequency of occurrence has been done in other study areas (Beck, 1991) and could provide actuarial data as a basis for insurance coverage of buildings. The development mechanism of voids in unconsolidated cover overlying karstic bedrock has been understood for many years (White and White, 1992). Cover-collapse formation is driven by a loss of cohesion and surcharge loading from a wetting front, which results in a loss of strength of the regolith arch (Tharp, 1999).

The project area is a 2 square mile quadrangle in east-central Christian County, Kentucky. The exposed geologic section, in ascending order, is Mississippian Ste. Genevieve Limestone, Renault Limestone, and Bethel Sandstone (Klemic, 1967). The limestones are oobiosparites and micrites, medium-to thick-bedded, and have a high carbonate content. Interbedded thin shale and argillaceous carbonates are a minor interruption to the otherwise very pure carbonate section. The topography within the study area is karst plain and a single low hill of 77 ft local relief formed by the basal 30 ft of the Bethel Sandstone. The Bethel is a calcite-cemented, argillaceous quartzarenite and weathers into a friable, porous, sandy soil that readily slumps into underlying sinkholes (Klemic, 1967). The Lost River Chert is exposed near the base of the Ste. Genevieve in local quarries, but is below the depth of karst development in the study area. The exposed Ste. Genevieve Limestone is over 170 ft thick. The cover-collapses inventoried were mostly in the outcrop area of the Renault Limestone, some 50 to 95 ft thick. Land use is largely pasture and cropped fields with scattered farmsteads, a retail agriculture supply, a cement plant, and a restaurant.

KGS staff examined enlargements of black and white, low-altitude, visible-light aerial photographs. The photographs were taken March 9, 1971, and January 31, 1991. Contact prints for the Tennessee River Valley, at an image scale of 1:12,000 (1 in. = 1,000 ft) were used in stereo pairs. The enlargements were 1:3000-scale (1 in.=250 ft). We field-checked 49 features seen on the photographs and identified 15 as cover collapse developed within the 20-year time frame. KGS was told of several collapses that occurred after 1971 that had been filled and graded over prior to the 1991 picture. We found conclusive field evidence that 3 reported cover collapses had been filled and they were counted. The inventory results are shown in Table 1.

In planning this study we anticipated some limitations on the accuracy of the rate of cover collapse. First, the size of the study area is too small to be strictly statistically valid (Beck, 1991). Second, artificial effects of the quarry operation on the rate of cover collapse was in question. The quarry activity is thought to be negligible because the quarry became inactive shortly after 1971. We did not find a pattern either in the field or on the photographs that suggests any clustering induced by the quarry. Finally, the method does not work in densely wooded areas, although woodlands can still be field checked, which we did.

Table 1. Results of inventory and field-verified cover-collapse events between aerial photograph by TVA in 1971 and 1991.

Study area, 1971 and 1991 photography	Number of cover-collapse	Inventory Area	Cover-Collapse Events per unit area	Cover-Collapse Events/Unit Area/Year
Area of quarry included	18	1.90 mi^2	9.47 CC/mi^2	0.47 $CC/mi^2/yr$
Area of quarry excluded	18	1.56 mi^2	11.53 CC/mi^2	0.58 $CC/mi^2/yr$

The field verification of suspected cover collapse identified on large scale aerial photographs proved practical and more accurate than analyzing case histories. The rate of cover-collapse events for Christian County is 0.58 $CC/mi^2/yr$, which is higher than many previous studies (0.29 $CC/mi^2/yr$, Beck, 1991). The probability of a house being affected was calculated with the method of (Wilson and Shock, 1996). We estimate that 438,000 single-family homes are on karst terrain in Kentucky, with an average living space of 1,902 ft^2 (U.S. Department of Energy, 2001). The rate from this study suggests that 14 to 17 houses are affected annually by cover collapse.

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KENTUCKY SPARROW MODEL AND ITS APPLICATIONS TO UNDERSTANDING NUTRIENT LOADS

Tanja N. Williamson, PhD, Hydrologist
USGS Kentucky Water Science Center
9818 Bluegrass Parkway
Louisville, KY 40299-1906
Ph 502-493-1868
Fx 502-493-1909
tnwillia@usgs.gov

SPARROW (SPAtially Referenced Regression on Watershed Attributes) uses monitoring data in a statistically based land-use and land-attribute model that incorporates source and delivery variables in order to estimate contaminant loads for non-monitored streams. In Kentucky, a statewide SPARROW model is available for mean annual nitrogen and phosphorus loads using 1992 data as a baseline. This model is based on a combination of spatial data, with resolutions varying from 100 m^2 to 25 km^2, and a stream network with a mean watershed size of 6.0 km^2. The resolution of the input data limits the applicability of the model to watersheds where the total drainage area is on the order of several hundred km^2. One such watershed is Floyds Fork (743 km^2), east of Louisville. Current issues of concern in the watershed include phosphorus, nitrogen, pathogens, and sediment. The current SPARROW model only addresses relative nutrient contributions for the six largest stream segments within Floyds Fork. However, an improvement in the sampling data and spatial data resolution of the model would address nutrient contributions in the smaller tributaries, as well as hopefully enabling an understanding of sediment contributions. This talk will discuss the possible improvements in development of the model for smaller watersheds as well as how this local model relates to the national and regional SPARROW modeling efforts.

NOTES